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# UNORDERED FEATURE TRACKING MADE FAST AND EASY

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## Abstract

We present an efficient algorithm to fuse two-view correspondences into multi-view consistent tracks. The proposed method relies on the Union-Find [1] algorithm to solve the fusion problem. It is very simple and has a lower computational complexity than other available methods. Our experiments show that it is faster and computes more tracks.

**Keywords:** Tracking, Structure from Motion, computer vision.

**Introduction.** The problem of feature points tracking is to follow the position of a characteristic point in a set of images. These multi-view correspondences are called **tracks**. Track identification in a set of images (ordered, or not) is an important task in computer vision. It allows solving geometry-related problems like video-stabilization, tracking, match-moving, image-stitching, structure from motion and odometry.

**The track problem.** Considering  $n$  pairwise feature correspondences as input we want sets of corresponding matching features across multiple images, as illustrated in fig.1 with video frames.

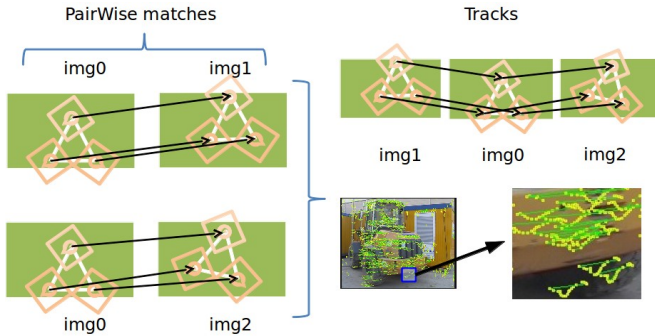


Figure 1: From pairwise frame matches to video tracks. Green lines link features positions in first and last frame.

**Existing solutions.** In the case of unordered feature tracking, the standard available algorithms, Bundler [2] and ETH-V3D [3] do not solve the problem in an optimal way, producing outputs that depend on the pairing order. Besides, they are complex and require at least  $O(n \log n)$  operations (correspondence sorting).

**The Union-Find approach.** Our solution is simple and does not depend on the image pairing order (algo.1). A singleton is initially created for each matched feature. Then each pairwise match entails the union of the two sets containing them. Each resulting set corresponds to a track. The key ingredient is the join function built on the Union-Find algorithm to fuse correspondence subsets, defined as  $\text{join}(a,b) = \text{union}(\text{find}(a), \text{find}(b))$ . The complexity is  $O(n \alpha(n))$  where  $\alpha$  grows like the inverse of the Ackermann function — i.e., quasi-linear in practice.

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## Algorithm 1 Unordered feature tracking

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**Require:** list of pairwise correspondences

**Ensure:** tracks

```
create a singleton for each feature
for each pairwise match do
    join({leftMatch}, {rightMatch})
end for
return each connected set as a track
```

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**Experimental results.** We have performed experiments on large datasets: up to 2,600 images, with more than 41 million pairwise matches, yielding a million tracks. We compared our method with Bundler and ETH-V3D. It is up to 4 times faster, with a median speedup of 1.8. Moreover it is able to find more tracks than Bundler and ETH-V3D on all tested data, on average a 10% increase.

**Conclusion.** The simplicity of our method guarantees the reliability of the track computation; it actually produces more tracks than existing methods. Moreover, it has arguably the lowest possible complexity and is indeed faster than other methods.

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## References

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